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SURVEY ON FOOD CALORIE ESTIMATION USING DEEP LEARNING AND COMPUTER VISION

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Abstract : Nowadays, people are more concerned about their diet due to COVID-19. A number of diseases are increasing day-by-day such as heart diseases, high blood pressure, diabetes, etc. These diseases are increasing due to over consumption of oily food, high sugary contents, junk food, many more which leads to obesity. Even COVID-19 has proved the importance of intake of sufficient nutrients to build a strong immune system. So, in order to keep a track of the intake of necessary nutrients and to avoid over consumption of fatty and high cholesterol foods, we have proposed a system that will estimate the approximate amount of calories present in the food. This system can run on mobile as an application as well as on a desktop as a system. The system carries out image acquisition, object detection, and calorie estimation as some of the processes.

IndexTerms - Image processing, food image recognition, food calorie estimation, convolutional neural network , Computer vision , Deep learning.

I. INTRODUCTION

Todays' young generation is more careless about their diet. They don't look after what are they eating. And as the world is getting faster , people don't consider what they are eating, they are just busy in their work and consume whatever looks attractive even if it is highly fatty. Every time the attractive foods are not healthy. For this, we need to keep control of ourselves and keep a watch on what we are eating and how does it is going to affect our body. So, to keep a track of the number of calories we consume, we have tried to propose a system of mobile application which will provide the user with the calorie content present in the food by clicking its picture. In this paper, we propose a System for food calorie estimation from a single photo that runs on an Android smartphone or on the web or a desktop system as well. We are implementing a system as a stand-alone mobile application that can be used even on an airline or in the subway (underground) where an Internet connection is not accessible, taking into account its usability and mobility. Once the user downloaded and installs the application, even if an Internet connection is not there it will work. So, it is also useful for people living in remote areas.To estimate the calories present in the food, the user, first of all, needs to register a standard reference object whose size is known. Then the user needs to click a picture of the food as well as the reference object which is Image Acquisition. As a reference object user can use anything which he/she carries with him/her always like a thumb, wallet, etc. After taking the picture, the system will segment the objects by creating bounding boxes around the food and the reference object, and then it will compare the images with the images in the dataset by giving the volume of the food. And then after the calculation of the volume, the system will insert the value of the volume in a standard formula and then the user will get the output

II. LITERATURE SURVEY OR RELATED WORK-

Despite this, a variety of approaches for automatically estimating food calories have been developed. In this portion of the article, we go over them in detail.

Koichi Okamoto, Keiji Yanai [1] "An Automatic Calorie Estimation System of Food Images on a Smartphone " Department of Informatics, The University of Electro-Communications, Tokyo, Japan - In this method, they offer a meal calorie estimating system that runs on a consumer smartphone and includes the following components:

1. Take a meal photo from the top with a reference object, reference object which was used in this system was a food plate of a predefined size. **2**. Extraction of the food item and reference object regions. Using K-means clustering and grab cut methods. **3**. Recognize food categories of the detected food items. Using CNN algorithm **4**. Calculate the real sizes of the foods items present in images and food calories based on the pre-trained relations between sizes (volume and shape) and standard calories. These are 4 main steps that were included in the system where accuracy was quite high and also the recognition speed was also high. But this system process image containing only one food item at a time and multiple food item processing were not possible here.

Chen et al. [2] so here in his proposed system, an image-based food calorie estimation method was using RGB-D images which were captured by depth cameras such as Kinect. It was challenging to execute the technology on mobile devices since depth cameras are uncommon and consumer cell phones lack them.

Meghana M Reddy, [3] "Calorie-estimation-from food images openCV", GitHub repository, May 2016. Here in this system what they have done is that they used SVM (support vector machine) algorithm in other to classify the images which are quite good if data is not big but it currently gives not good enough results on big data containing a large number of images. Another thing is that for object extraction and segmentation they have used too many filters of OpenCV which decreases the speed of processing. Also, the system needs to have 3 objects must in it, those are 1 big plate, only 1 fruit and 3^{rd} is reference object in this case they used the thumb as a reference object. Nowadays the popular method which is closely used for object detection techniques and one of the best in object detection and object recognition techniques is Regions based Convolutional Neural Networks (R-CNN) Which further have 2 more advanced versions namely Fast R-CNN and Faster R-CNN. The Faster R-CNN technique is much faster than many methods available out there but it is also costly to train the model on a machine because it needs much more GPU power.

R-CNN method by y Girshick et al. [4] R-CNN divides the overall detection issue into two subproblems: using low-level signals like color and texture to produce category-agnostic item placement suggestions (RPN – Region Proposal Network) and using CNN classifiers to identify object categories at those locations. The precision of bounding box segmentation with low-level signals, as well as the incredibly potent classification capacity of state-of-the-art CNNs, are combined in this two-stage technique. In our detection approaches, we used a similar pipeline, although we looked at improvements in both phases, such as multi-boxing.

Author Chiun-Li Chin et al. [5] have divided the food into six groups according to similar nutritional properties. The UNICT-FD889 dataset with the UECFoodl00 dataset was used for training and testing in deep learning. The system can classify and identify the nutrient according to their groups, but performance is a major issue due to less training and testing. Moreover, it works well for a limited dataset.

PROPOSED SYSTEM -

In this paper, we propose a food calorie estimation system running on a user's smartphone or it can be also used on a PC or on the Web. In this proposed system user needs to take a photo of food items from their smartphone with the pre-registered Reference object. The system will then categories those food items into pre-defined food item categories before estimating the number of calories in each of the food items observed.

Our main processing steps of the proposed system are as follows:

1. Image Acquisition.
2. Object Detect for the food items as well as the required reference object.
3. Image Segmentation of objects from step 2.
4. labeling of Objects and Volume Estimation.
5. Calorie Estimation.

We presume that a meal photo is taken from the object's Front View in our mobile system. To make segmentation easier, we assume that the background of food dishes is uniform rather than textured. Furthermore, we presume that the reference object's size is known. In fact, in the system we are implementing, a user can record the size of a reference object that is anticipated to be in their own possession, such as a coin, or the user can register their Thumb as their reference object.

Here As we are planning to create a system that detects the objects out from the complete picture and that enables us to be more flexible in sense of we can use more than 1 pre-defined reference object and also multiple food object detection will be easy but for better results, we assume that user will use background surface as uniform such as dish plate, then food should be present and picture should be taken a good exposure of light and at least 1 pre-defined reference object should be present in the picture which is going to be provided as input to the system..

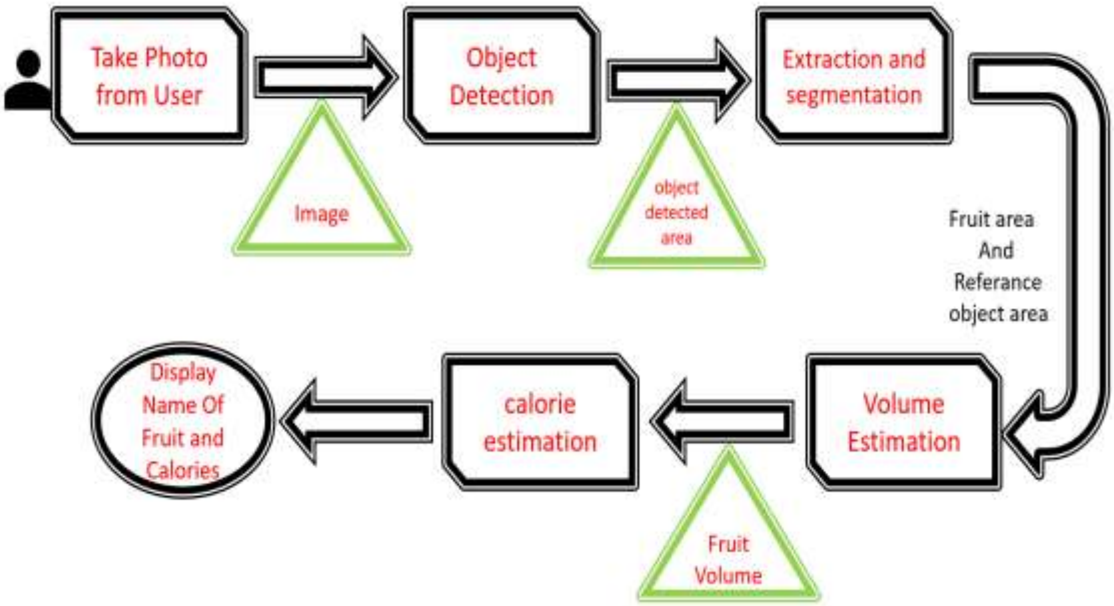

Fig 1: Diagram of system

DETAIL OF THE METHODS

1. **Image Acquisitions**:
   For datasets, we gathered many food images in order to train our model and there are food datasets available at Kaggle like Food_360 and other FooDD dataset
   We assume that users will take a photo from their smartphone or supply the image having good light intensity present in it and the background should be uniform.

2. **Object Detection**:

here is an example Here suppose this is the input Image that the user supplied then the system will detect the object out of it considering basic edge detection methods are used.

3. **Segmentation**:

Here in the left image, you can see that object is region is separated from the rest of the image then using segmentation for object extraction techniques such as grab cut or Utsu method of thresholding techniques present in computer vision which makes our work quite easy to do. The same goes for reference objects.

Foods	Density (g/cm^3)	Calorie (kcal/g)	Label	Shape
Apple	0.609	0.52	1	Sphere
Banana	0.94	0.89	2	Cylinder
Carrot	0.641	0.41	3	Cylinder
Cucumber	0.641	0.16	4	Cylinder
Onion	0.513	0.40	5	Sphere
Orange	0.482	0.47	6	Sphere
Tomato	0.481	0.18	7	Sphere

Table: the standard value of density & calories and labels.

4. **Volume Estimation**:
   We have 3 factors from image segmentation
   1. Foods pixel area
   2. Skin pixel area
   3. Actual skin area (skin multiplier)

   From these factors food estimated area is given below:
   Estimated Food Area = Foods Pixel Area ∗ Actual Skin Area of Skin Pixel Area

   We have two types of shapes of foods
   1. Sphere - like apple, orange, tomato, onion
   2. Cylinder – like banana, cucumber, carrot

   Volume estimation for Sphere :

   Estimated Radius =ER

   $ER = \sqrt{(\text{Estimated Food Area} / \Pi)}$

   And Estimated Volume = EV

   $EV = 4/3 * \Pi * ER^3$

5. **Calorie Estimation**:
   For the calorie estimation, we are going to make use of a pre-defined table having the value of labels and standard density, and also with that respect, we have calories values.

   Estimated Weight = Actual Density of food ∗ Estimated Volume

   Estimated Calories = Estimated Weight ∗ Calories Per 100 gm / 100

CONCLUSION :

From this survey paper, it's seen that we can implement an image-based calorie estimation system that runs on a user's smartphone without the need for external recognition servers. By just taking a photo of a meal from the front using a pre-registered reference object, the system estimates food calories automatically.

For this process, we can conclude that computer vision algorithms for Segmentation and object extraction and Strong CNN algorithms are best suited for the identification of food and estimating calories of food present in the image.

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